Elpo

OPERATING INSTRUCTIONS

BEDIENUNGSANLEITUNG

ELECTRONIC INSTRUMENTS

ELEKTRONISCHE MESSGERÄTE

Warszawa — Poland — Polen

TRANSISTORISED MILLIVOLTMETER

t y p e

V - 6 1 5

OPERATING INSTRUCTION

Contents:

1. APPLICATION

The Transistorised Millivoltmeter type V-615 has been designed for the measurement of sinewave AC voltages. It can be applied for measurements of voltage levels, gain, attenuation and for plotting frequency response curves in the frequency range of 20 c/s to 3Mc/s. Above 3Mc/s, up to 5 Mc/s the instrument may be applied as voltage indicator for comparative and bridge measurements.

In view of its universal power supply facitities--mains or internal storage battery - the instrument may be used in laboratory and workshop practice, as well as in exterios applications.

2. TECHNICAL DATA

Measurement ranges

Voltage measurement range:..........100 µV to 300V

Subranges:

- direct input ....0-1-10-30-100-300 mV,
- via input probe:(1000:1)..0-1-3-10-30-100-300V.

Level measurement range:...........-72 to +52 dB, re.0.775V

- subranges:...............12 subranges in 10dB steps

Response to:.........................peak value

Calibration:.........................r.m.s. value of sine-voltage.

Accuracy

Maximum error, at 1 Mc/s...........± 2% f.s.d.

Frequency variation:..........2% of indication 30 c/s to 1 Mc/s

± 3% of indication 1 Mc/s to 2Mc/s

± 5% of indication 2 Mc/s to 3Mc/s

Supply voltage
variation.......... ± 1% of indication, 30 c/s to 1 Mc/s

± 3% of indication, 1 Mc/s to 3 Mc/s

Temperature variation ($10^{o}C$ to $35^{o}C$): ± 2% of indication per $10^{o}C$

Internal noise

referred to the input, with

1000 Ohm source resistance:..... 30 µV

Input impedance

subranges 1mV to 300 mV:............. ca 1 MOhm and 30 pF

subranges 1V to 300V:............... 1 MOhm ± 2% 15 pF

Power supply

mains:................................ 120/220V 50 c/s

internal:.............................10V built-in storage battery 0.9Ah, gas-proof

Permissible supply voltage fluctuation:

mains supply:..................-15 % to +10% of nominal

internal supply:..............8.5V to 12V

Consumption

from mains....................below 4VA

from battery..................below 12mA

Battery charging..............automatic, during mains operation

Battery check.................built-in meter

Dimensions and weight

Outer dimensions:.............ca 160x240x140 mm

Weight (incl.battery):.........ca 4 kG.

3. OPERATING PRINCIPLE

The Transistorised Millivoltmeter Type V-615 has been designed for the purpose of measuring AC voltages over a wide frequency and level range (down to fractions of 1 mV). Thus its main part is a transistorised wide-band, high-gain amplifier, increasing the testnsignal level up to an amplitude required for effective performance of the diode detector.
The amplifier consists of two similar sections, each comprising 3 amplifies stages operating within a loop of effective negative feedback. The feedback exceeds 30dB over the entire frequency range of the instrument maintaining the amplifier gain constant irrespective of transistor characteristics instability, supply voltage fluctuation and ambient temperature variation. After being amplified the test signal is applied to the rectifier using germanium diodes arranged to a peak-value detector.
The DC detector output feeds the moving coil meter, calibrated directly in terms of voltage units.
The input impedance of the main amplifier is rather low, and a direct introduction of the test voltage into the amplifier would present considerable load for the test voltage source. Thus a buffer stage has been included between the input socket of the instrument and main amplifier. The buffer circuit has been dimensioned for high input and low parallel capacitance.
The buffer stage consists of two emitter followers within an auxiliary feedback loop, the latter reducing

the effect of the collector-to-base conductance on the input impedance of the stage. The voltage gain of the buffer stage is close unity.
1mV input will produce full scale deflection of the moving coil meter. To extend the measuring range a stepwise variable attenuator (0-10-20-30-40-50 dB) has been inserted between the buffer stage and the main amplifier. Further range extension is provided by the high-resistance RC divider mounted in the input probe case, and reducing the signal 1000 times.
Measurement subrange selection is by means of a single, rotary, 6-position switch attering the attenuator setting and by applying the test signal directly or via the 1000:1 probe.
The block diagram of the instrument is shown in Fig.1.
The instrument circuits can be supplied from the 50 c/s mains or from an internal gas-proof nickel-cadium storage battery. The internal battery requires no monitoring a maintenance as it is charged automatically when the instrument is mains-operated. The fully-discharged battery is charged during ca.20 hours, and its capacity being great enough for ca 50 hours of continuous operation.
The battery condition is monitored by means of the built-in moving coil meter with the power supply switch set to "PROBA BAT." = BATTERY CHECK. Permissible voltage limits of the battery are shown at the meter scale. The measurement error of the instrument is within the specified limits when the battery voltage is within these voltage ranges.

4. CIRCUITRY

4.1. Voltage divider.

At the subranges 1mV to 300mV the test signal is applied directly to the buffer stage input. At the subranges 1V to 300V between the test signal source and the instrument input socket the voltage divider should be inserted. The divider consists of high-stability resistors R52, R53[x] and ceramic capacitors C25, C26. The divider ratio at low and medium frequencies is determined by the resistor values. To maintain the same ratio over the higher frequency range of the instrument the divider is compensated by the parallel capacitors, according to:

$$R52 \times C' = R53 \times (C25 + C26 + C''),$$

where C' and C" represent the stray capacitance of the wiring referred as parallel to resistors R52 and R53, respectively. The divider components are placed within the probe case. A cable is fitted to the probe for connection to the instrument input socket. The ratio of the divider amounts to 1000:1.

Thus, the maximum output voltage of the probe amounts to 300mV, these being simultaneously the maximum voltage which may be applied directly to the instrument input.

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x) Symbols for components, as shown in the circuit diagram of the instrument.

4.2. Buffer stage

The voltage divider input is applied via the instrument input socket to the buffer stage, driving the main amplifier of the Millivoltmeter. The buffer stage consists of two emitter followers with transistors T1, T2. The T2v emitter follower is loaded by the attenuator input resistance; the input resistance of this follower presents in turn the load for the T1 emitter follower.
As known, the input impedance of an emitter follower is approximately equal to the product of current gain and load impedance of the stage. In the case of the two-stage circuit used in the instrument the thearetical input impedance is approximately equal to the attenuator input resistance multiplied by the product of current gains of the two transistor stages. To achieve this value in the practical circuit it is necessary to compensate the effect of the transistor T1 collector to the base conductance, shunting the input impedance of the stage.
In order to reduce this effect the collector of T1 is connected via capacitor C4 to the circuit point having in respect to AC the potential of the buffer stage output.
Since the voltage gain is close to unity, the collector potential of T1 is close to its base potential. Thus, the current via the collector-to-base conductance of T1 is forced by the residual potential difference only, the latter being con-

siderably smaller than the input voltage. Thus, the equivalent collector-to-base conductance, shunting the buffer stage input is many times smaller than the actual conductance of transistor T1.

In effect of using the two-stage emitter-follower with reduced collector-to-base conductance, the input resistance of the buffer stage is similiar to this of conventional vacuum tube millivoltmeters.

4.3. Attenuator

The attenuator consists of five L-type pads using high-stability throughout. The attenuation of each pad amounts to 10 dB. The in-circuit attenuation is variable by means of the P1c switch, selecting the point at which, the signal is derived from the attenuator. When set to position "1mV" the switch connects the main amplifier input directly to the buffer stage output. At the remaining subranges, corresponding to positions 3mV to 300 mV the switch inserts successively the subsequent attenuator pads increasing the in-circuit attenuation in 10 dB steps.
The same applies to the switch P1c function at the subranges 1V to 300V, however the test signal is applied in this case to the external probe comprising the 1000:1 voltage divider.

4.4. Amplifier

With the range switch set as required to obtain a convenient meters reading, (i.e. corresponding to

the test voltage value/, the output level from the attenuator never exceeds 1mV, this signal providing the drive for the two cascade-connected amplifier stages.

The first amplifier section consists of three stages with transistors T3, T4, T5 arranged to a common-emitter amplifier. The attenuator output is applied via capacitor C8 to the base of transistor T3, being the first amplifier stage. Its collector is supplied from the power source via the R23-R24 voltage divider to reduce the DC component in the collector voltage and current, thus decreasing the internal noise of transistor T3, determining the over-all noise factor of the amplifier. The collector of T3 is coupled directly to the base of the second amplifier stage, T4. Transistors T3 and T4 present a pair featuring automatic working condition stabilization as the DC component of the T3 base current is determined by the voltage drop across the emitter resistance of T4. The collector of T4 is capacitively coupled to the base of T5, the third amplifier stage. The emitter current of T5 will produce a voltage drop across resistor R22 inserted into the input circuit of T3. It causes a negative feedback loop including the three stages of the first amplifier section, extending the frequency range, flatening the frequency response, stabilizating the gain and increasing the input resistance of the amplifier. The feedback exceeds 30dB over the entire frequency range of the instrument providing good amplifier stability and thus greatly reducing the effect of transistor characteristics

changes, supply voltage fluctuation and ambient temperature variation on the instrument indication accuracy.

In addition to the described feedback loop including the three stages, auxiliary local feedback loops are included to the second and third amplifier stage at the R27-C10 and C13 components of the T4 and T5 emitter circuits. These are responsible for further improvement of the amplifier frequency response and elimination of any brend to oscillation, likely in the amplifier with over-three-stage feedback.

After being initially amplified in the first amplifier section, the signal, derived from the TS collector is applied to the second amplifier section. The second section, using three stages with T6, T7 and T8. The circuitry, as well as the principles of the second section are similiar to these of the first one, described above.

The over-all gain of the two amplifier section amounts to ca 500. Thus, at the collector of T8 0 to 500 mV are available.

4.5. Detector

The detector uses the two-way peak rectifier circuit with germanium diodes D1, D2, producing DC at the output, its value being directly proportional to the peak-to-peak amplitude of the applied signal. The detector output current is measured by the built-in moving coil meter calibrated in terms of input voltage. For gain adjustment of the instrument a preset resistor R34 is

inserted in series with the meter, the R34 has been adjusted at the manufacturer for specified measurement accuracy of the Millivoltmeter.

4.6. Power supply unit

As mentioned above the instrument can be supplied from the AC mains or from an internal gas-proof nickel-cadium storage battery. When mains operated, the DC supply is provided via the D3, D4, D5, D6 diode rectifier for the circuit and for the purpose of recharging the storage battery. The voltage and the rectifier internal resistance have been dimensioned so, that, with fully charged battery /maximum voltage/, the charging current is reduced to a safe level.

The switch P2 is used for switching on/off, for the selection of the power source and additionally, for switching-over the built-in meter for battery check.

4.7. Construction

Most of the individual components of the instrument are mounted on three printed boards, the first accepting the buffer stage, the second the amplifier and the third the power supply components with power supply selector contacts. The attenuator components are mounted directly at the printed stator wafers of the subrange switch. The moving coil meter is fixed directly to the front panel of the instrument. The storage battery is placed in a special recess in the case rear panel and it

is accessible after removing the screw-fixed cover plate. The battery is connected to the circuit by means of plugs, at the power supply printed board; with the instrument in its case, the plugs mate the sockets mounted in the recess wall. The mains voltage selector switch /120V-220V/ and the fuses are comprised in the power supply board. To gain access to these components it is just necessary to remove the rear panel cover plate.

5. OPERATING INSTRUCTIONS

5.1. Power supply selection

The instrument can be supplied from 50 c/s mains or from the internal storage battery. The battery is charged when the instrument is mains operated. Thus, use always the mains supply when possible. It will keep the battery charged and always ready to supply the instrument when no mains is available.

Mains voltage fluctuations within - 15% to + 10% of the nominal do not affect the instrument performance. With mains supplied below - 15% the accuracy will remain unaffected, however the battery charging current will be inadequate to charge the full battery capacity, and the charging will be prolonged. At mains voltage ca 30% there is no current left for charging; the battery voltage may exceed the mains rectifier voltage and in fact the instrument will be supplied by the battery and not from the mains leading towards the dis-

charging of the battery.
However, the measurement accuracy will be maintained as specified as long as the battery voltage is within the range marked on the meter scale.

5.2. Mains supply

Before connecting the instrument to the mains, make sure that it is adjusted to your mains voltage; to check the adjustment, undo the two screws fixing the small cover plate at the rear panel gaining access to the fuses and the main voltage selector switch. To alter the adjustment remove the screw from its position, say near the inscription "220V", and screw-in into another thread, say near the inscription "120V".
When leaving the manufactorer, the instrument is normally adjusted to 220V operation.
To connect the instrument to the mains use the cable, terminated in the standard mains plug - at one side - and in a special plug mating the pins behind the rear panel - at the other.
The mains is switched on by setting the power supply switch /lower left-hand corner of the front panel/ from position "WYŁ" /OFF/ to "WŁ SIEC." /MAINS ON/.
If the instrument was out-of-use for a longer period and the battery is completely before commencing the measurement wait ca. 5 minutes after switching on.
Having completed the measurements switch mains off by setting the power supply switch to position "WYŁ"/OFF/

NOTE: When out-of-use never leave the power supply switch set to "WŁ.BAT" /BATT.ON/, "PROBA BAT" /BATT.CHECK/ or "WŁ.SIEC" /MAINS ON/ - otherwise the battery will completely discharge.

5.4. Measurement

Connect the test signal source to the instrument input, using one of the test leads supplied with the instrument /voltages of the mV - range/, or the 1000:1 probe with the BNC-plug-terminated cable mating the front panel socket /voltages of the V-range/. It should be born in mind, that the capacitance of the lead connecting the instrument to the source is effectively added to the instrument input capacitance, specified order "Technical Data". Thus, use always leads which are as short as possible. This is particularly important at frequencies above the AF-range.

Set the subrange switch of the instrument to a position corresponding to the test voltage value./Full scale deflection values are given on the front panel, near each position of the switch/. Should the test voltage be anknown, interconnect the 1000:1 probe and set the subrange switch to 300 mV, next reducing the f.s.d. sensitivity until convenient deflection is obtained.

Read the result on the corresponding meter scale and multiply by the factor of the subrange switch and the probe ratio-if applicable. When measuring voltage levels, referring to 0.775V, read the result at the meter dB scale, add the attenuation value of the subrange switch, and 60 dB- when using the probe.

The instrument will respond to the peak-to-peak amplitude of the test signal, however the calibration is in terms of R.M.S. values of AC sinewave voltage. Thus, when measuring distorted waveforms an additional error will be experienced, its value increasing when the crest factor x/ of the test signal differs from that/or the sinewave. Since the crest factor of AC signals is determined not only by the harmonic content, but also by phase relations, no reliable predictions can be made on account of the error due to the waveform distortion.

5.5. Battery operation and maintenance

The internal storage battery consists of 8 series connected gas-proof nickel-cadium cells, type KR 0.9. The battery is charged by the mains rectifier during mains operation of the instrument.

The battery voltage provides indication of the charge only when the mains is disconnected from the instrument. To be sure, that the battery is charged up to its full capacity, the instrument should be connected to the mains for at least 20 hours.

For satisfactory performance of the instrument, the battery voltage should be 8.5 to 12V, the upper limit being achieved during charging, with the instrument connected to the mains, Just after disconnection the voltage drops to ca 10.5V and is maintained within 10.5 to 9.5V during ca 25 hours of operation. During the further 20 to 45 hours of operation the battery will loose its full charge.

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x/ Crest factor = $\frac{\text{peak value}}{\text{RMS value}}$

The nominal capacity of the storage battery amounts to ca. 0.9 Ah. Will the battery in perfect condition /actual capacity close to the nominal/ and fully-charged, the instrument may be battery operated for 80 - 100 hours.

When the instrument was out of use for a few months the battery may discharge fully, down to a voltage close to zero. It should be noted, that such a discharge will produce no harm to the battery, however it should be next charged for a longer time than usually, i.e. ca 30 hours.

No special care or maintenance is required for the battery. Long-term chargings, as well as full discharging will produce no harm to the cells. The battery may be stored as long as required, in charged- as well discharged condition. The only precaution which should be observed is to limit the charging current.
<u>The charging current of KR 0.9 cells should never exceed 80 mA</u>.

This condition is satisfied automatically when the battery is connected to the mains rectifier of the instrument, and the above precaution should be observed only when using another source for charging the battery.

6. ACCESSORIES

The V-615 Transistorised Millivoltmeter is supplied together with the following accessories:

- 1 pc Mains cable, plugs filled
- 1 pc Test lead, terminated with coaxial plugs at both sides
- 1 pc 1000:1 probe with cable and plug
- 1 pc Test lead, terminated with coaxial plug at one side and banana plugs at the other
- 1 pc Operating Instruction

The storage battery / 8 KR 0.9 cells/ is mounted within each supplied V-615.

We reserve the right to alter either the circuit or the list of components.

L I S T   O F   C O M P O N E N T S

Circ. ref.	N a m e	Characteristics	Notes
R1	Compound resistor	OWS 122-0.1W-430 Ohm ±5%	
R3	" "	OWS 122-0.1W-150kOhm±5%	
R4	" "	OWS 122-0.1W-4.7kOhm±5%	
R5	" "	OWS 122-0.1W-1kOhm±5%	
R6	" "	OWS 122-0.1W-3kOhm±5%	
R7	" "	OWS 122-0.1W-6.8kOhm±5%	
R8	" "	OWS 122-0.1W-2kOhm±5%	
R10	" "	Rmx2-0.1W-742.5Ohm±0.5%	Resista
R11	" "	Rmx2-0.1W-742.5Ohm±0.5%	"
R12	" "	Rmx2-0.1W-742.5Ohm±0.5%	"
R14	" "	Rmx2-0.1W-742.5Ohm±0.5%	Resista
R15	" "	Rmx2-0.1W-742.5Ohm±0.5%	"
R16	" "	Rmx2-0.1W-502Ohm±0.5%	"
R17	" "	Rmx2-0.1W-502Ohm±0.5%	"
R18	" "	Rmx2-0.1W-502Ohm±0.5%	
R19	" "	Rmx2-0.1W-502Ohm±0.5%	"
R20	" "	Rmx2-0.1W-343.5Ohm±0.5%	"
R21	" "	OWS 122-0.1W-47 kOhm±5%	
R22	" "	OWS 122-0.1W-51Ohm±5%	
R23	" "	OWS 122-0.1W-10kOhm±5%	
R24	" "	OWS 122-0.1W-10kOhm±5%	
R25	" "	OWS 122-0.1W-4.7kOhm±5%	
R26	" "	OWS 122-0.1W-1kOhm ±5%	
R27	" "	OWS 122-0.1W-220Ohm±5%	
R28	" "	OWS 122-0.1W-6.8kOhm±5%	
R29	" "	OWS 122-0.1W-4.7kOhm±5%	
R30	" "	OWS 122-0.1W-3.3kOhm±5%	
R31	" "	OWS 122-0.1W-220Ohm±5%	
R32	" "	OWS 122-0.1W-47kOhm±5%	

Circ. ref.	N a m e	Characteristics	Notes
R33	Compound resistor	OWS 122-0.1W-56...82Ohm ±5%	matched in-circuit
R34	" "	OWS 122-0.1W-10kOhm ±5%	
R35	" "	OWS 122-0.1W-10kOhm ±5%	
R36	" "	OWS 122-0.1W-3.3kOhm ±5%	
R37	" "	OWS 122-0.1W-1kOhm ±5%	
R38	" "	OWS 122-0.1W-220 Ohm ±5%	
R39	" "	OWS 122-0.1W-6.8kOhm ±5%	
R40	" "	OWS 122-0.1W-33kOhm ±5%	
R41	" "	OWS 122-0.1W-1.5kOhm ±5%	
R42	" "	OWS 122-0.1W-220Ohm ±5%	
R44	" "	OWS 122-0.1W-3.3kOhm ±5%	
R43	Preset potentiometer	PKd-300-2.5kOhm - horizont.	
R46	Preset potentiometer	PKd-300-25kOhm -horizont.	
R47	Compound resistor	OWS 122-0.1W-120kOhm±5%	
R48	" "	OWS 122-0.1W-75 Ohm ±5%	
C1	Tantalium capacitor	KTF-2 uF - 50V	
C2	" "	KTF-2 uF - 50V	
C4	" "	KEM - 100 uF - 12/15 V	
C5	" "	KEM - 100 uF - 12/15 V	
C6	" "	KEM - 100 uF - 12/15 V	
C7	" "	KEM - 100 uF - 12/15 V	
C8	" "	KTF - 2uF - 25V	
C9	" "	KEM - 10 uF - 3/4 V	
C10	Mica capacitor	KSO-1-62pF±5%-B	
C11	Electrolytic capacitor	KEM - 4 uF - 30V	
C12	Ceramic capacitor	KCR-N47-33...56 pF	matched in-circuit

Circ. ref.	Name	Characteristics	Notes
C13	Ceramic capacitor	KCR-N47-88...100 pF	matched in-circuit
C14	Electrolytic capacitor	KTF/KEM-3...4 uF/25V	"
C15	" "	KEM-10 uF-3/4V	
C16	Mica capacitor	KSO-1-62 pF ±5%	
C17	Electrolytic capacitor	KTF - 2 uF - 25V	
C18	Capacitor	KCR-N47-0...39 pF	matched in-circuit
C19	Ceramic capacitor	KCR-N47-20 pF	
C20	Tantalium capacitor	KTF-25 uF - 25V	
C21	" "	KTF-25 uF - 10V	
C22	Electrolytic capacitor	KEM-100 uF-12/15V	
C23	" "	KEK-500 uF-25V	
C24	Foil capacitor	KSK-012-25x12-47000pF ± 5%-125V	
C25	Ceramic capacitor	KCP-N47-2D...47 pF	
C26	Trimmer ceramic	TCP-max. 25 pF	
R48	Compound resistor	OWS 122-0.1W-750 Ohm ±5%	
R50	" "	OWS 122-0.1W-2kOhm ±15%	
R51	" "	OWS 122-0.1W-33kOhm ±5%	
R52	" "	RmL 75-1W-1MOhm ±0.5%	
R53	" "	RmL2-".1W-1kOhm ±0.5%	
R49	" "	OWS 122-0.1W-510 Ohm ±5%	
T1	Germanium transistor	AF-125 Siemens u Halske	
T2	" "	AF-125 " "	
T3	" "	AF-125 " "	
T4	" "	AF-125 " "	
T5	" "	AF-125 " "	

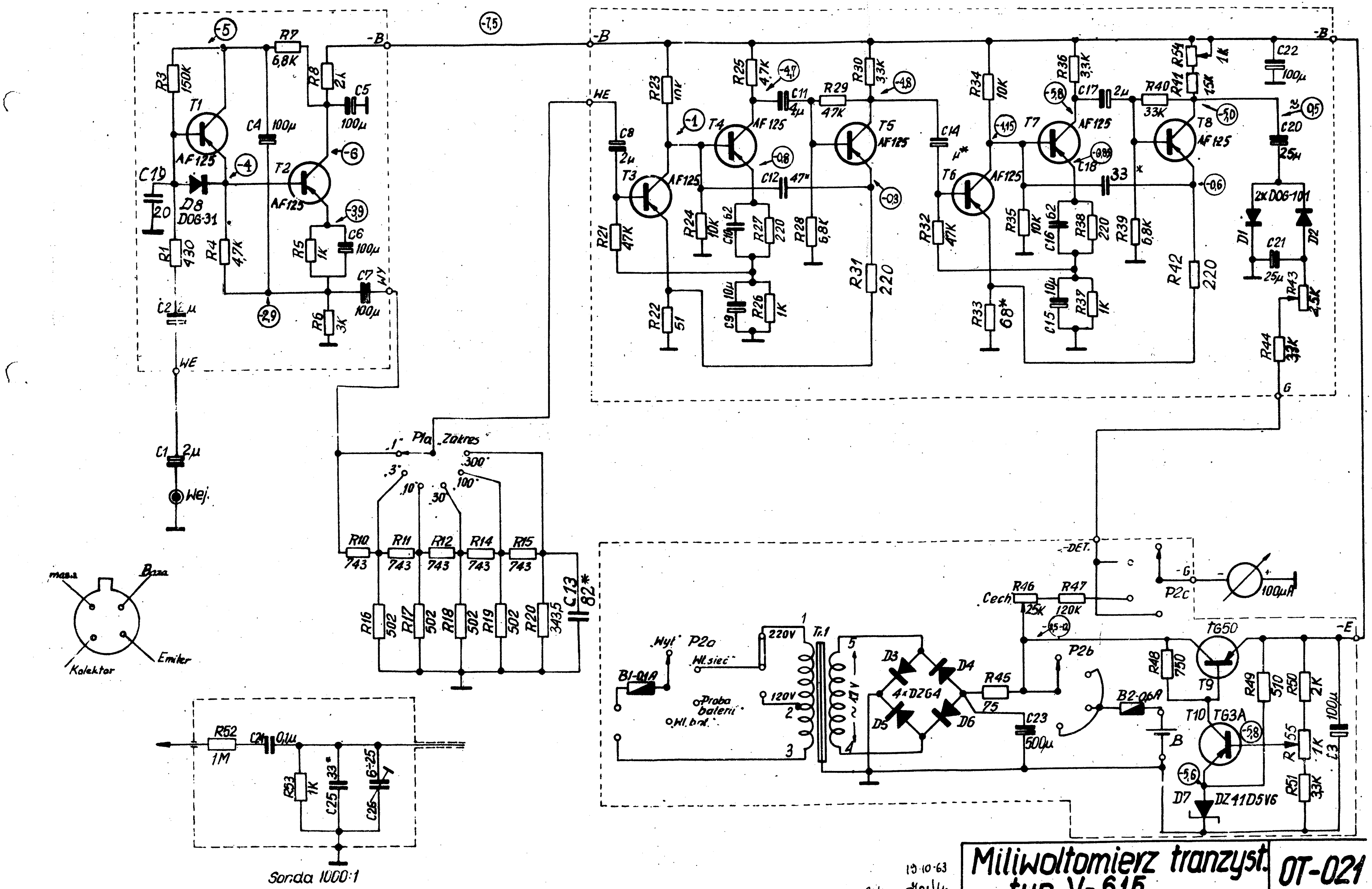
Circ. ref.	N a m e	Characteristisc	Notes
T6	Germanium transistor	AF-125 Siemens u Halske	
T7	" "	AF-125 " "	
T8	" "	AF-125 " "	
T9	" "	TG-50	
T10	" "	TG-3A	
D1	Germanium diode	DOG-101	selected
D2	" "	DOG-101	selected
D3	" "	DZG-4	
D4	" "	DZG-4	
D5	" "	DZG-4	
D6	" "	DZG-4	
D7	Zener diode		
G1	Mov. coil meter	MEA-4-0....100 uA	
Tr1	Mains transformer		WI-PW-044
B1	Fuse	B_{tr} - 0.16 A	
B2	"	B_{tr} - 0.60 A	
P1	6 pcs - switch		
P2	4 pos - switch		Printed on power cupply board
B	Storage battery	8 cels type KR-0.9 series connected	
R54	Preset potentiometer	PKd - 300-1 k Ohm - horiz.	
R55	" "	PKd - 300 -1k Ohm - vertic.	
D8	Diode germanium	DOG-31	

Pow.Sp.Pr."Zespół" zam. 1042 /65/ 50

TRANSLATION OF FRONT PLATE DESCRIPTION

1. Miliwoltomierz tranzystorowy
   Milivoltmeter transistorised
2. Masa - Earth
3. Baza - Base
4. Kolektor - Colector
5. Emiter - Emiter
6. Zakres - Range
7. Cech. - Cal.
8. Wyłącznik - Swith
9. Wł. sieciowy- Mains on
10. Próba baterii - Batt. test
11. Wł. baterii - Batt. on
12. Sonda - Probe

Uwaga! Zastrzega się prawo wprowadzania zmian układowych oraz w spisie elementów.



Miliwoltomierz tranzyst. typ V-615

OT-021

19.10.63

PROTOKOŁ BADANIA

Miliwoltomierza Tranzystorowego Typ V-615 Nr.fabr.........

2.2.1. Dokładność wskazań przy 1 kHz wg. WT ± 2% w stosunku do pełnego wychyleni miernika.

Punkty skali / Zakresy pomiarowe	Rzeczywisty wynik pomiaru			
	04	0,6	0,8	1
1 mV	0,4	0,6	0,8	1,01
10 mV	4,02	6,04	0,799	10,11
100 mV	40,2	60,7	80,1	101
1 V	4,09	0,6	0,8	0,995
10 V	4,01	6,07	7,93	9,96
100 V	40,0	60,1	79,8	100,6

Potwierdzenie zgodności ....
/podpis i pieczęć kontrolera/

Punkty skali / zakresy pomiarowe	Rzeczywisty wynik pomiarów		
	1	2	3
3 mV	1,01	2,02	3,02
30 mV	10,4	20,3	30,2
300mV	100,1	198,0	304,0
3 V	1,0	1,99	2,98
30 V	10,0	19,9	29,8
300 V	98,2	197	

Potwierdzenie zgodności ....
/podpis i pieczęć kontrolera/

2.2.2. Charakterystyka częstotliwościowa
a/ dla podzakresu 100 mV przy nap. U= 80 mV.

Częstotliwość/Hz/	30 Hz - 1 MHz					1 MHz - 2 MHz		2 MHz - 3 MHz		
Dopuszczalna wart. wskazania /mV/	40 Hz	60 Hz	1 kHz	500 kHz	800 kHz	1 MHz	1,6 MHz	2 MHz	2,5 MHz	3 MHz
Wskazan. rzecz. przyrząd. badan. /mV/										

2.2.2. b/ Dla podzakresu IV: przy nap. U= 0,8 V

Częstotliwość /Hz/	30 Hz - 1 MHz					1MHz-2MHz		2MHz-3MHz		
Dopuszczalna wartość wskazania /mV/	0,784 - 0,816					0,776-0,824		0,76 - 0,84.		
	40 Hz	60 Hz	1 kHz	500 kHz	800 kHz	1 MHz	1,5 MHz	2 MHz	2,5 MHz	3 MHz
wskazania rzecz. przyrządu badanego /mV/										

Potwierdzenie zgodności ....
/podpis i pieczęć kontrolera/

2.2.3. Napięcie szumów własnych nie przekracza - przekracza 40 μV.

Potwierdzenie zgodności ....
/podpis i pieczęć kontrolera/

2.2.11. Kontrola nap. baterii akumulatorów.

Treść badań	w/g W.T.	Rzeczywisty wynik pomiaru
Początek sektora Próba baterii /V/	8,3 - 8,7	
Koniec sektora "Próba baterii" /V/	11,8 - 12,2	

Potwierdzenie zgodności ....
/podpis i pieczęć kontrolera/

Sprawdził:

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Zatwierdził:

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